CITY OF CUPERTINO
GENERAL PLAN AMENDMENT
1-GPA-80

TECHNICAL APPENDIX - F

ENERGY IMPACT ASSESSMENT

SEDWAY/COOKE
URBAN AND ENVIRONMENTAL
PLANNERS AND DESIGNERS

MAY 23, 1983

STATE CLEARINGHOUSE NUMBER 81030308

84 00073
App. F

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I. INTRODUCTION

A. PURPOSE

The purpose of this report is to identify energy impacts associated with the City of Cupertino's proposed General Plan revision. The proposed revision covers the planning period from the present to the year 1990. This report compares the energy impacts created by the existing General Plan (1990 Base Tier) to those which would be generated by the proposed General Plan revision (1990 Second Tier) and suggests possible mitigation measures for reducing the energy impacts of the two different alternatives.

B. ORGANIZATION

This report is organized into seven sections. This, the first section, explains the purpose and organization of the report. The second section summarizes all the data which has been collected and presents the conclusions reached from analysis of the data. The next four sections present the basic data by energy use sector and explain the methodologies used in this analysis. The last section is a glossary of terms and equivalent relationships used throughout the report. Review of this glossary will help in understanding the terminology used in the following sections

C. GROWTH ASSUMPTIONS

The following lists identify the growth assumptions assumed for the base tier and scond tier scenarios analyzed in this report.

Residential

Density Range Units/Acre	1980 Total # of Units	1990 Base and Second Tier Total # of Units
Less than 1	680	1,680
1-5	9,750	10,350
5-10	2,450	2,700
10-20	3,210	3,770
20-35	-	1,110
Total	16,090	19,610

Commercial/Industrial (square feet)

	Existing (1983)	Base Tier	Second Tier
Commercial	3,069,000	3,400,000[1]	3,790,000[1]*
Office	850,000	2,465,000	3,017,000
Industrial	4,370,000	5,846,000	6,028,000

[1] The new commercial development is split with 12% going into restaurant space and the rest into retail.

* In addition to this square footage an 850 room, 640,000 square foot hotel would be added.

II. SUMMARY

A. RESIDENTIAL ENERGY DEMAND

The 1990 second tier growth plan does not project any additional residential development beyond that projected in the base tier plan so there are no additional residential energy impacts produced by the second tier plan. The base tier plan projects a 22% increase in total units over 1980 levels but the energy impacts of this new residential development are minimal. Assuming a reasonable[1] amount of conservation in existing units the projected delivered energy demand for all units is estimated to decrease slightly from current levels even with the new construction. This reduction in demand is expected due to increased efficiency resulting from cost effective energy conservation measures. Primary energy demand is expected to increase with the base tier growth but only to a level 3% above 1980 levels.

B. COMMERCIAL ENERGY DEMAND

The 1990 second tier growth plan projects major increases in the commercial sector over the base tier level. Thus the estimated energy demand also increases. Some conservation is expected and factored in but even with conservation, delivered electrical and natural gas consumption in the commercial sector is expected to increase 8% and 35% respectively over the 1990 base tier levels with the second tier growth. This represents an overall delivered energy increase of 87% over 1980 energy use in the commercial sector. The 1990 base tier is estimated to increase energy demand 36% over 1980 levels. Approximately half of the increase in commercial energy demand from the 1990 base tier to the second tier is the result of the projected hotel complex.

C. INDUSTRIAL ENERGY DEMAND

Industrial development increases 3% over the 1990 base tier with the second tier plan. Energy demand is expected to increase at approximately the same rate. Some future energy efficiency can be expected in the use of natural gas but any new efficiency gains in electrical use are likely to be negated by industrial process changes requiring more electrical power.

By 1990 industrial energy demand is expected to reach approximately $1,134 \times 10^9$ Btus per year under the second tier plan. This is a 3% gain over 1990 base tier levels and a 37% gain over 1980 levels but represents only approximately 11% of the overall total 1990 second tier estimated delivered energy demand for all sectors.

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[1] See Section III, Tables III-4 and III-6 for a detailed explanation of the conservation measures assumed. For the purposes of estimating future energy consumption it was assumed that market incentives will stimulate 50% of the 1980 housing stock to be retrofitted with some form of energy conservation by 1990. PG&E's ZIP (zero interest loan program) is one form of incentive for this type of conservation activity and is presently available as a form of financing for residential energy conservation programs.

D. TRANSPORTATION ENERGY DEMAND

Transportation by far exceeds all other sectors of energy consumption in 1980, under the base tier plan and with the second tier plan. The second tier plan increases the amount of vehicle miles traveled generated by development in the city 8% and 32% respectively over base tier and 1980 levels. This increase in vehicle miles traveled causes an increase in energy consumption for the second tier over 1990 base tier levels, but the estimated total energy consumption under the second tier is still below 1980 energy consumption totals due to expected increases in gas mileage for the average auto on the road. 1990 transportation energy consumption is estimated to be $6,538 \times 10^9$ BTUs per year, a large amount of energy but representing only 93% of the 1980 consumption.

E. OVERALL ENERGY DEMAND

Tables II-1 and II-2 compare operational energy demand for 1980, 1990 base tier and 1990 second tier conditions by energy use sector and fuel type. The estimated overall annual operational energy demand for the 1990 second tier represents a 9% increase over 1990 base tier levels but only a 3% increase over 1980 levels. The majority (65%) of the energy demand under the second tier plan is in the transportation sector. This is down from 72% in 1980. Figures II-1 and II-2 illustrate the percentage energy demand for each land use scenario by energy end use sector and energy type. From the base tier to the second tier all land uses increased in overall energy demand but commercial energy demand increased slightly as a percentage of the total energy demand, while the residential sector decreased. Industrial and transportation remained at the same level as a percentage of the total.

Estimated embodied energy under the second tier plan increased from slightly over $3,500 \times 10^9$ Btus with the base tier to around $4,000 \times 10^9$ Btus. Embodied energy is expected to increase as a percentage of total energy consumption due to increased energy use efficiencies in operational energy consumption.

F. POTENTIAL MITIGATION TECHNIQUES

Table II-3 lists the potential energy conservation measures described more fully in later sections of the report. The table summarizes the potential energy savings of each conservation measure and compares them to each other. The measures listed in the table represent several alternatives for reducing overall energy demand but in no way represent all possible techniques. Further conservation could be achieved if the measures listed were applied more stringently or if other measures were added. Figure II-3 illustrates the reduction in energy which could be achieved by applying the conservation measures listed in Table II-3 to the 1990 second tier plan. Just from these conservation techniques overall energy demand could be reduced from 10%-14% or enough to lower the 1990 second tier (base tier plus additional development) energy demand below the estimated energy demand for 1990 base tier development without the conservation measures listed in Table II-3.

Because transportation accounts for by far the largest energy consumption of any sector it also represents the greatest potential for conservation. Within the Cupertino area there is great potential for further development of carpooling (beyond that listed in Table II-3), mass transit, and other forms of conservation in the transportation sector. Through further conservation in this energy use sector the overall energy consumption could be significantly reduced.

The residential and commercial energy conservation measures listed in this report and summarized in Table II-3 probably represent reasonable maximum attainable energy conservation goals for those energy use sectors. On the other hand, the energy conservation measures listed for the transportation sector could be more easily achieved and surpassed. Through the use permit process the city could require that Transportation System Management (TSM) programs be applied with any new development in the city. These programs can increase carpooling, vanpooling, flexible working hours, etc. to the point that energy use is significantly reduced. TSM programs administeered through the use permit process may represent the most cost effective energy conservation program that the city could administer.

TABLE II-1

CITY OF CUPERTINO
COMPARISON OF OPERATIONAL ENERGY DEMAND
FOR GROWTH ALTERNATIVES BY ENERGY USE SECTORS
BTUs X 109

Year	Residential	Commercial	Industrial	Transportation	Total
1980	1,303	625	827	7,006	9,760
1990 Base Tier	1,250	852	1,097	6,056	9,260
1990 Second Tier	1,250	1,169	1,134	6,538	10,090

TABLE II-2

CITY OF CUPERTINO
COMPARISON OF OPERATIONAL ENERGY DEMAND FOR
GROWTH ALTERNATIVES BY FUEL TYPE
(BTUs x 10^9)

Year	Natural Gas	Electricity	Gasoline	Total
1980	1,536	1,218	7,006	9,760
1990 Base Tier	1,638	1,562	6,056	9,260
1990 Second Tier	1,855	1,696	6,538	10,090

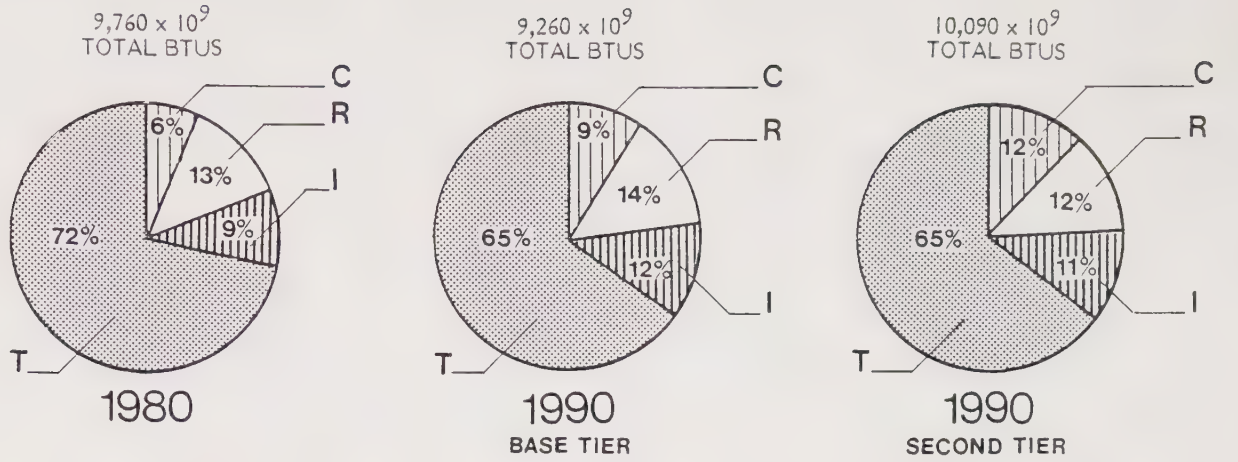
TABLE II-3

CITY OF CUPERTINO
COMPARISON OF ALTERNATIVE ENERGY CONSERVATION MEASURES

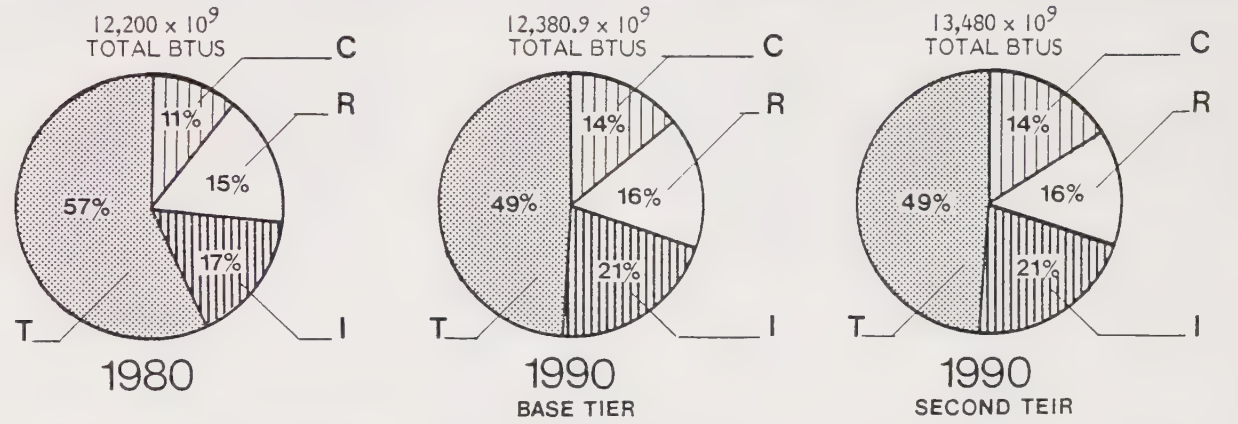
	Total Delivered Energy Saved Under 1990 Base Tier Development Plan		Total Delivered Energy Saved Under Second Tier Development Plan	
	%	BTUs $\times 10^9$	%	BTUs $\times 10^9$
Residential				
(1) Solar hot water heater (applies to all new and existing units)	3%	236	2%*	236
(2) Solar hot water heater (applies to all new units)	<1%	40	<1%	40
(3) Increased density (new SFD changed to MFD)	1%	105	1%*	105
(4) Increased conservation standards beyond Title 24	3%	247	2%*	247
(5) Passive solar heating/cooling (applied to all new units)	<1%	45	<1%*	45
Commercial				
(6) Conservation package applied to all new construction beyond Title 24 See text for description of package	3%	321	5%	491
Industrial				
None	-	-	-	-
Transportation				
(7) Increased carpooling (up from 20% to 50% of those commuting by auto)	3%	256	3%	273
Maximum Feasible Savings with combination of conservation measures	8%-12%	900-1,200	10%-14%	1,100-14,00

* The second tier growth plan does not include any additional residential units beyond those in the base tier plan. the actual saving in BTUs for the residential sector conservation measures would be the same for both the base tier and second tier plans but the percentage savings goes down in the second tier plan due to the overall rise in energy consumption from that plan.

FIGURE II-1



DELIVERED ENERGY BY SECTOR

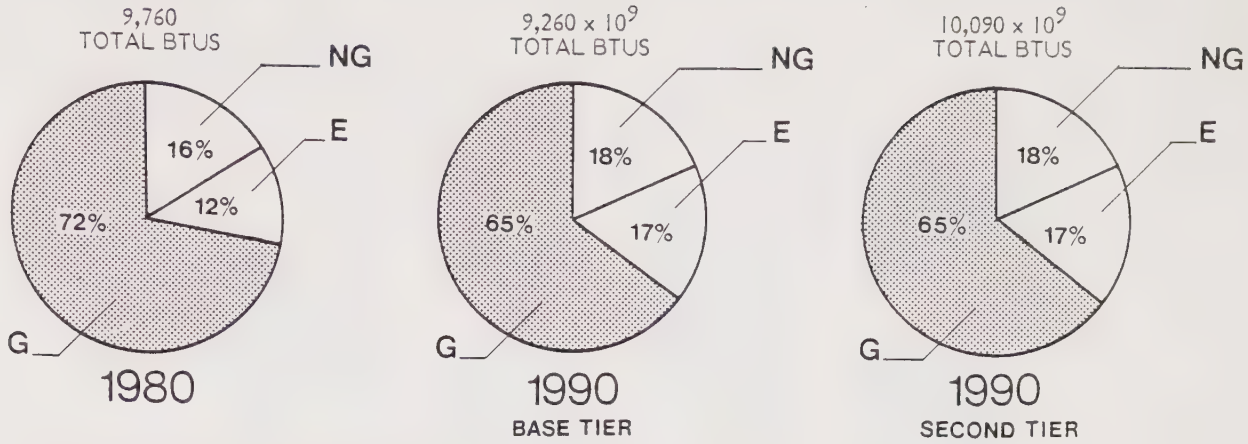


PRIMARY ENERGY BY SECTOR

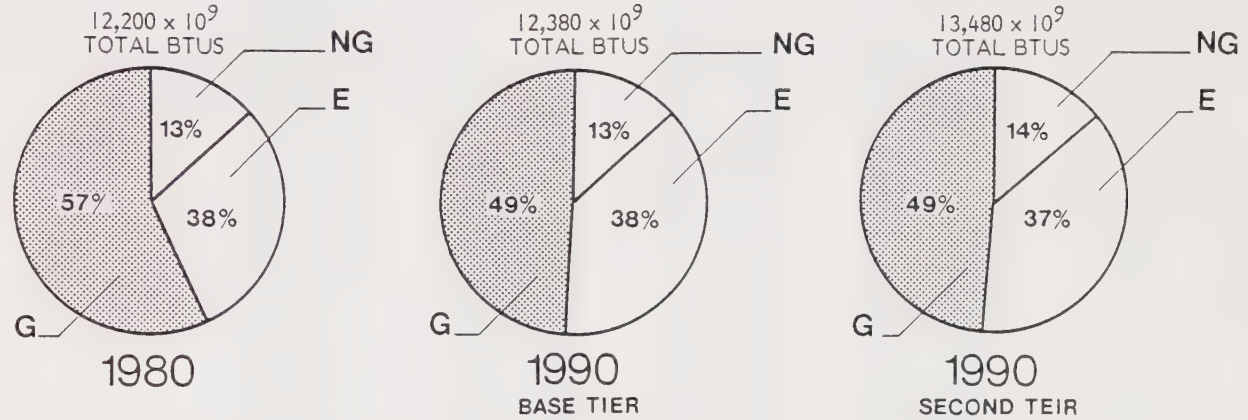
EXCLUDES EMBODIED ENERGY

I INDUSTRIAL C COMMERCIAL R RESIDENTIAL T TRANSPORTATION

FIGURE II-2



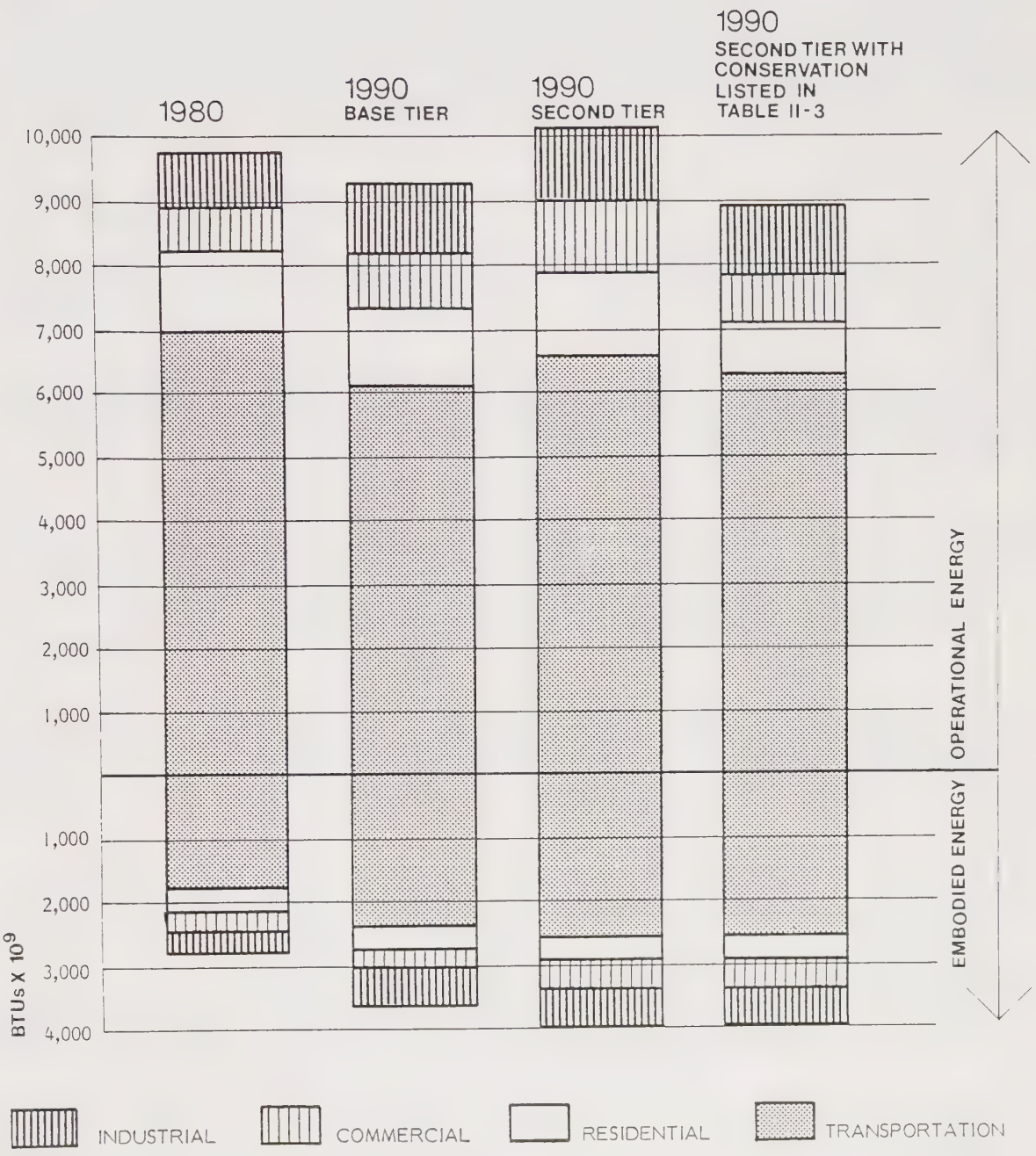
DELIVERED ENERGY BY FUEL TYPE



PRIMARY ENERGY BY FUEL TYPE

NG NATURAL GAS **E** ELECTRICITY **G** GASOLINE

FIGURE II-3. CITY OF CUPERTINO CITYWIDE ANNUAL DELIVERED ENERGY USE BY END USE SECTOR



III. RESIDENTIAL ENERGY USE

A. HOUSING STOCK

The first step in identifying energy use in the residential sector is to identify the number of housing units currently existing in the city. Table II-1 lists the number of single family and multiple family dwelling units existing in Cupertino in 1980 and the number of units planned for in the General Plan Base Tier Addition for 1990. No additional housing units would be added with the General Plan Second Tier Addition. With the 1990 General Plan Base Tier Addition single family and multiple family dwelling units are expected to increase in numbers over 1980 levels by 16% and 32% respectively.

B. ENERGY CONSUMPTION

The second step in identifying energy use in the residential sector is to identify existing energy use and to estimate per unit energy use for the existing and new structures in the future.

1980 Baseline Energy Use. Table III-2 lists actual 1980 delivered energy use in the residential sector as recorded by Pacific Gas and Electric. Assuming that mulitple family units use approximately one half the energy a single family unit uses, the estimated 1980 average annual per unit energy use is $1,430 \times 10^5$ Btus for single family unts and 715×10^5 for multifamily units.

1990 Projected Energy Demand With Base Tier Growth. Table III-3 shows the annual delivered energy use per unit for single and multiple family units which are constructed under Title 24 standards. All new construction is required to comply with Title 24 therefore these per unit figures have been used to estimate the 1990 operational energy demand for units constructed since the standards were imposed.

Space heating is the largest energy consumer in a single family detached unit while light and power is the largest energy consumption category in multifamily units. Figure III-1 illustrates the percentage of delivered energy used for space heating, domestic hot water heating, and light and power for new units built under Title 24 standards.

It is anticipated that half of the housing stock built before Title 24 standards came into effect will have been retrofitted by 1990 with at least the most cost effective energy conservation measures. Thus the energy use by the existing housing stock should be less than current levels by 1990. Table III-4 outlines the conservation measures which would most likely be used in any residential energy conservation program. The total energy savings potential for these conservation measures is approximately 500×10^5 Btus per unit or a potential total annual savings of approximately 250×10^9 Btus when applied to half the housing stock.

Table III-5 outlines the average annual energy use for the City's 1990 base tier housing stock addition. Table III-6 summarizes Tables III-2, III-4, and III-5 information to arrive at the total delivered energy use for the residential sector with the General Plan Base Tier Addition. Assuming that 50% of the existing single family dwelling units will be retrofitted with conservation measures the 1990 residential, direct operational energy use is estimated to be less than that consumed in 1980 even with

the increase in residential stock permitted in the base tier growth. Primary residential delivered energy use for 1990 is estimated to only increase 3% over todays levels even with the base tier growth due to the conservation measures assumed for the existing structures.

In addition to the delivered energy discussed above the base tier growth in the residential sector also represents an increase in embodied energy. Embodied energy is the energy consumed in the construction and maintanence of the house and the infrastructure which supports it. Table III-7 lists the embodied energy use per unit annualized over a 75 year replacement period. Per unit embodied energy consumption for new single family housing stock represents 21.4% of the total annual energy consumed.

1990 Projected Energy Demand with Second Tier Growth. The 1990 General Plan Second Tier Addition does not include any additional residential development beyond that in the base tier. Therefore, energy levels would not be effected by the second tier growth alternative.

C. POTENTIAL ENERGY CONSERVATION

Several conservation techniques which would further reduce residential energy use are discussed in the following paragraphs. Table III-11 is a summary table that compares the potential energy and financial savings of each energy conservation technique. The highest potential energy savings could be achieved by combining all the conservation techniques listed below and in the Table.

- o Solar domestic hot water heating
- o Increased housing density
- o Increased conservation standards (beyond Title 24 standards)
- o Passive solar space heating and cooling.

Potential Solar Hot Water Savings. Table III-8 shows the potential energy savings from the use of solar hot water heaters. It is assumed that a 70% savings in domestic hot water heating energy use would occur with the use of a solar hot water heater. The performance characteristic for the existing hot water unit assumed a gas heated hot water heater with a three inch insulation blanket. The potential 70% savings is based on performance expectations with natural gas back-up heating units supplying the remaining 30% of the operational energy use. Three energy saving scenarios are listed in the Table: applying the solar hot water heater to new multiple family units only, all new units, and all new units plus retrofitting all existing old units. The respective direct operational energy savings in the residential sector for each scenario would be, 1%, 3%, and 19%.

Potential savings with Increased Density. Table III-9 lists the potential energy savings available if the additional single family dwelling units added by the General Plan Base Tier Addition are converted to duplex units or multifamily units. Switching to all new units constructed as duplex and multifamily units would save 3% of the total energy used in the residential sector with the Base Tier Addition while switching to all new units constructed as multifamily units would save 5%.

Potential Savings with Increased Conservation Standards. Another potential energy saving technique would be to increase beyond Title 24 the conservation standards for the residential development added by the 1990 General Plan Base Tier Addition. Table III-10 lists the savings that could be achieved by each conservation measure.

The total additional energy savings that could be achieved for each unit is about 290 x 10^5 Btus a year. If these additional conservation measures were applied to all new single family homes a direct energy savings of 46 x 10^9 Btus could be achieved. If they were applied to all new single and multiple family units and 50% of the existing housing stock and additional savings of 247 x 10^9 Btus per year could be achieved.

Potential Savings with Passive Heating and Cooling. Simple passive solar design measures could also easily reduce energy use for space heating and cooling without any dramatic alteration to design of interior spaces. New single family dwelling units built with passive solar features could save 150-400 x 10^5 Btus for heating and approximately 22.6 x 10^5 Btus for cooling as compared to Title 24 standard construction.[1] The preliminary design actions which can achieve these savings are:

- Locate major living areas adjacent to south facing glazing for heat gain.

- Locate sufficient glazing on the south side for heat gain to displace January heat loss -- for the typical house about 200 square feet (in conjunction with the following characteristics).

    - Provide sufficient thermal mass in direct contact with sunlight to store 65% of heat gain.

    - Provide nighttime insulation over south facing glazing.

    - Summer shading of south facing glazing, e.g., roof overhang, arbor, awnings.

The use of air conditioners can be reduced substantially by adding ceiling insulation (R-30); attic ventilation; shading of east, west, and south windows, and east and west walls from July to September; and ventilation of living area. Shading and ventilation can be provided in many different ways, including:

Shading
- east and west windows (80 square feet)
    - transparent roll up shades
    - canvas awnings
- east and west windows, walls, and roof
    - shade trees
      four 24-inch box-size trees planted strategically will provide shade in approximately five years
      four in five-gallon can-size trees planted strategically will provide shade in approximately 10-15 years
- south windows (projection 1/3 the height of the window)
- arbor (attached to house)
- awning

Ventilation
- cross-ventilation through windows
- convection cooling-air intake on north wall/ceiling vent. (This works best in structures with open bean ceilings with a high point.)

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[1] Sedway/Cooke, Marin Countywide Plan Update Program, Appendix B Technical Report No. Ten, August 1980.

TABLE III-1

CITY OF CUPERTINO
HOUSING STOCK

	EXISTING IN 1980[1]	GENERAL PLAN BASE TIER ADDITION FOR 1990	1990 TOTAL	PERCENT INCREASE
SFD	9,998	1,598	11,596	16
MFD	6,090	1,924	8,014	32
TOTAL	16,088	3,522	19,610	22

[1]Source: City of Cupertino, General Plan Amendment 1-GP-80. September 1982.

TABLE III-2

CITY OF CUPERTINO
EXISTING (1980) RESIDENTIAL ENERGY USE

	# OF CUSTOMERS	SALES (therms or KWH)	DELIVERED ENERGY (Sales Converted to Btus x 10^9)	PRIMARY ENERGY CONSUMED (Btus x 10^9)
Natural Gas	11,266	10,207,292	1,020	1,020
Electricity	13,031	82,933,516	283	849[1]
TOTAL	--	--	1,303	1,869

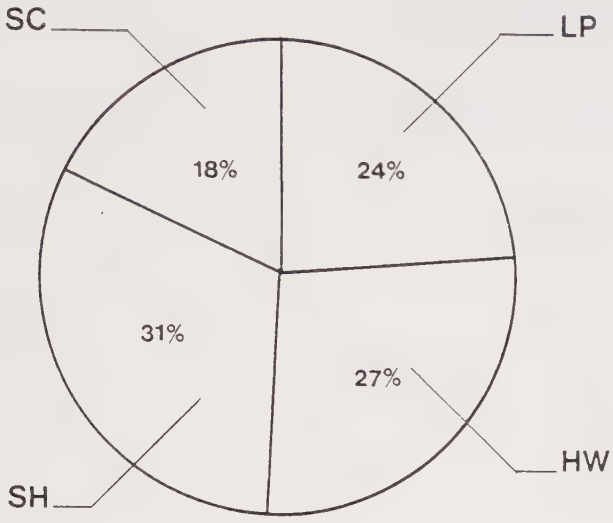
1 therm = 29.29 KWH

1 KWH = 3,413 Btus

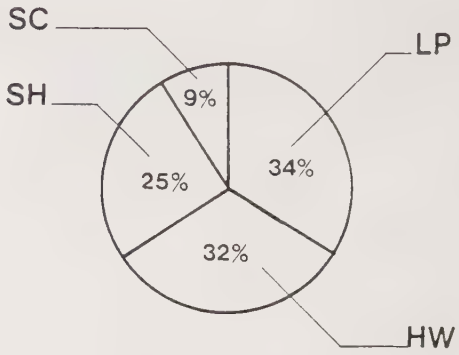
1 therm = 100,000 Btus

[1] Primary energy consumption estimates assume a 33% efficiency for delivered electrical energy. The remaining 67% represents energy losses due to transmission and generation.

FIGURE III-1. OPERATIONAL ENERGY CONSUMPTION FOR POST TITLE 24 RESIDENTIAL UNITS



SINGLE FAMILY (DETACHED)
768 BTUS x 10^5/UNIT



MULTI-FAMILY (ATTACHED)
383 BTUS x 10^5/UNIT

LP LIGHT & POWER **HW** DOMESTIC HOT WATER HEATING **SH** SPACE HEATING **SC** SPACE COOLING

Assumes space heating, cooling and domestic hot water are natural gas energy uses.

Assumed size of SFD unit is 2,400 square feet, MFD is 950 square feet.

Sources:

California Energy Commission, New Residential Building Standards Energy Conservation Manual, certified January 1982.

Sedway/Cooke, Marin Countywide Plan Update Program, Energy Element, Technical Report #6, Energy Demand and Supply, February 1980

TABLE III-3

CITY OF CUPERTINO
POST TITLE 24 ANNUAL ENERGY USE
PER RESIDENTIAL UNIT

SINGLE FAMILY DWELLING

ENERGY USE	(Btus x 10^5/sq. ft.)	PRIMARY ENERGY (Btus x 10^5 unit)[2]	DELIVERED ENERGY (Btus x 10^5/unit)[3]	% OF TOTAL DELIVERED ENERGY
Space Heating	.099	238	238	31%
Cooling	.057	137	137	18%
DHW	------	206	206	27%
Light & Power	------	561	187	24%
TOTAL	------	1,142	768	100%

MULTIPLE FAMILY DWELLING

ENERGY USE	(Btus x 10^5/sq. ft.)	PRIMARY ENERGY (Btus x 10^5 unit)[3]	DELIVERED ENERGY (Btus x 10^5/unit)[3]	% OF TOTAL DELIVERED ENERGY
Space Heating	.102	97	97	25%
Cooling	.036	34	34	9%
DHW	------	123	123	32%
Light & Power	------	387	129	34%
TOTAL	------	641	383	100%

[1]Source: California Energy Commission, New Residential Building Standards Energy Conservation Manual, certified January 1982.

[2]Assumes space heating, cooling and domestic hot water are natural gas energy uses.

[3]Assumed size of SFD unit is 2,400 square feet, MFD is 950 square feet.

*Source: Sedway/Cooke, Marin Countywide Plan Update Program, Energy Element, Technical Report #6, Energy Demand and Supply, February 1980.

TABLE III-4

CITY OF CUPERTINO
ASSUMED CONSERVATION PACKAGE FOR EXISTING HOUSING STOCK

CONSERVATION MEASURE	SAVINGS (Btus x 10^5)
Caulking	100
R 19 Ceiling	234
Heat Duct Insulation	80
In Unheated Areas (20% of energy use for heating)	25
Automatic Setback Thermostat	25
Water Heater Insulation to Three Inches and Pipe Insulation	35
2 1/2 Gal/Min Showerhead	22
TOTAL	496

NOTE: This analysis evaluates energy savings for a dwelling unit that has an uninsulated ceiling. For houses with some ceiling insulation savings will be less substantial.

Source: Sedway/Cooke, Marin Countywide Plan Update Program, Energy Element Appendix B, Technical Report #10, August 1980.

TABLE III-5

CITY OF CUPERTINO
AVERAGE ANNUAL ENERGY USE, GENERAL PLAN
1990 BASE TIER HOUSING STOCK ADDITION[1] ONLY
(Btus x 10^9)

UNIT TYPE	# OF UNITS	DELIVERED ENERGY PER UNIT			TOTAL DELIVERED ENERGY			PRIMARY ENERGY PER UNIT			TOTAL PRIMARY ENERGY		
		electric	n. gas	total	electric	n. gas	total	electric	n. gas	total	electric	n. gas	total
SFD	1,598	.0187	.0581	.0768	29.8	92.8	122.6	.0561	.0581	.1242	89.6	92.8	182.4
MFD	1,924	.0129	.0254	.0383	24.9	48.9	73.7	.0387	.0254	.0641	74.5	48.9	123.4
TOTAL	—	.0316	.0835	.1151	54.6	141.7	196.3	.0948	.0835	.1883	164.1	141.7	305.8

[1] Assumes new units have gas space heating, cooling, and domestic hot water heating.

TABLE III-6

CITY OF CUPERTINO
ESTIMATED 1990 ANNUAL OPERATIONAL ENERGY USE IN THE
RESIDENTIAL SECTOR WITH GENERAL PLAN BASE TIER ADDITION

		DELIVERED ENERGY, Btus x 10^9	% OF EXISTING (1980) ENERGY USE	PRIMARY ENERGY, Btus x 10^9	% OF EXISTING (1980) ENERGY USE
Existing 1980 Housing Stock Energy Use:	electric	283	22%	849	45%
	natural gas	1,020	78%	1,020	55%
Potential Energy Savings From Conservation Measures Applied To Older SFD Housing Stock[1]:					
	electric	0	0%	0	0%
	natural gas	250	19%	250	13%
SUBTOTAL		1,053	81%	1,619	87%
Estimated 1990 GP Base Tier Additional Housing Stock Energy use[2]:					
(SFD + MFD)	electric	55	4%	164	9%
	natural gas	142	11%	142	8%
TOTAL 1990 ENERGY USE		1,250	96%	1,925	103%

[1]Assumes 50 percent of the existing SFD housing stock (9,998 D.U.) will be retrofitted with energy conservation measures by 1990. The energy conservation will save 5.0 x 10^5 Btus per dwelling per year. (See Table III-4 for a breakdown of this savings by conservation measure.) Because the majority of this potential energy savings is through insulation and the energy saved would be natural gas, the primary energy and delivered energy potential savings are the same.

[2]Assumes new units have gas space heating, cooling, and domestic hot water heating.

TABLE III-7

CITY OF CUPERTINO
EMBODIED ENERGY PER RESIDENTIAL UNIT
(Direct and Indirect Annualized Input)
in Btus x 10^5

	Existing Stock		New Stock	
	SFD	MFD	SFD	MFD
Site Development[1] Construction	--	--	51	18.4
Construction Inputs[1]	--	--	193	81.0
Utility Infrastructure Operation and Maintenance	66.5	54.6	66.5	54.6
TOTAL	66.5	54.6	310.5	154.0
Percent of Total Primary Energy Use	--	--	21.4%	19.4%

Source: Interactive Resources, Inc. "Guidelines for Evaluating New Development in Contra Costa County." Vol. 2. Contra Costa County Planning Department, Martinez, California. May 1976.

[1] Annualized over a 75-year period.

TABLE III-8

CITY OF CUPERTINO
POTENTIAL SAVINGS FROM SOLAR HOT WATER HEATERS

HOUSING TYPE	% ENERGY SAVED BY SOLAR HOT WATER HEATER[1]	ENERGY USE FOR GAS HEATED HOT WATER UNIT WITH INSULATION (Btus x 10^5/Unit)	ENERGY SAVED BY INSTALLING SOLAR HOT WATER HEATING (Btus x 10^5/Unit)	# OF HOUSING UNITS WITH 1990 GP BASE TIER ADDITION	Total Direct Energy Savings Applied to		
					New MFD Btus x 10^9	All New Units	All New Units Plus Retrofit All Old Units Btus x 10^9
SFD	70%	206	144	11,596	0	23.0	167.0
MFD	70%	123	86	8,014	16.5	16.5	68.9
TOTAL	—	—	—		16.5	39.5	235.9

[1] Assume a 70 percent savings in energy use for domestic hot water heating. The 70 percent savings factor is applied to the estimated energy use of a gas heated hot water heater with a three-inch insulation blanket already installed.

TABLE III-9

CITY OF CUPERTINO
POTENTIAL ENERGY SAVINGS FROM
HIGHER DENSITY RESIDENTIAL DEVELOPMENT
(Btus x 10^9)

	Estimated 1990 Energy Use with GP Base Tier Housing Stock		Estimated 1990 Operation Energy Use with Duplex Units Replacing SFD in Base Tier Addition[1]		Estimated 1990 Operational Energy Use with All New Units as MFD in Base Tier Addition	
	Direct	Primary	Direct	Primary	Direct	Primary
Total Annual Operational Use	1,250	1,925	1,221	1,887	1,187.9	1,844.8
Total Annualized Embodied Energy use for New Residential Building Stock	-	79.2	-	64.2	-	54.2
Total Energy Percent Savings Over 1990 Base Tier		0%		3%		5%

[1] Assumed size of units:
SFD = 2,400 square feet
DUPLEX = 1,500 square feet
MFD = 950 square feet

TABLE III-10

CITY OF CUPERTINO
ADDITIONAL CONSERVATION PACKAGE BEYOND
TITLE 24 STANDARDS (in addition to Table III-4)

CONSERVATION MEASURE	SAVINGS PER UNIT (Btus x 10^5)
R-30 Ceiling (as compared to R-19)	16
R-11 Walls	110
R-19 Floor (if crawl space or basement)	55
Insulating Shades	108
TOTAL	289

TABLE III-11

CITY OF CUPERTINO
COMPARISON OF POTENTIAL ENERGY SAVING TECHNIQUES

CONSERVATION TECHNIQUE	ANNUAL POTENTIAL DELIVERED ENERGY SAVINGS (Btus x 10^9)	POTENTIAL SAVINGS 1983 $	FINANCIAL PER YEAR[1] 1990 $
Solar Hot Water Heaters Applied to:			
- New MFD Units only	16.5	69,000	121,300
- All New Units only	39.5	165,100	290,300
- All New Units Plus Retrofit Existing Housing Stock	235.9	986,100	1,733,900
Increased Housing Density			
- New SFD in Base Tier Switched to Duplexes	53.0	157,800[2]	277,600[2]
- New SFD in Base Tier Switched to MFD	105.2	384,700[2]	676,700[2]
Increased Conservation Measures Beyond Title 24 Standards Applied to:			
- All new SFD	46.9	196,000	344,700
- All new SFD and MFD and 50% of Existing Housing Stock	247.0	1,032,500	1,815,500
Passive Solar Heating Applied to:			
- All New SFD Stock	24.0 - 63.9	100,300 to 267,100	176,400 to 469,700
Cooling Applied to:			
- All New SFD Stock	3.6	15,000	26,500

Source: California Energy Commission, California Energy Demand, 1980-2000, Vol. I, Technical Report, Revised November 1980.

[1] Assume electrical costs of 6.01¢/kwh 1983 dollars, 10.58 ¢/kwh 1990 dollars. Natural gas costs of $4.18/Btu x 10^6 1983 dollars, $7.35/Btu x 10^6 1990 dollars.

[2] Excludes potential financial savings from decrease in embodied energy.

IV. COMMERCIAL ENERGY USE

This section of the energy analysis deals with energy consumed by commercial and public service land uses. Existing energy use data was available by Standard Industrial Code (S.I.C.). However, projected growth land use data was available only in more generalized categories. Therefore, in order to analyze the data it was consolidated into the categories listed below. These categories remain consistent throughout the remainder of this report.

- Office (includes public and private office development and public service offices such as police and fire stations)
- Restaurants
- Food Stores (includes all major grocery stores)
- Warehouse
- Schools (includes all schools elementary through college)
- Medical Facilities (includes any major health care facility)
- Motels/Hotels
- Retail (includes all retail shops except restaurants and major grocery stores)
- Miscellaneous (other small service oriented shops)

A. COMMERCIAL BUILDING STOCK

Table IV-1 lists total square footage figures for the existing commercial building stock (including office development), the projected stock in the 1990 general plan base tier addition, and the projected stock in the 1990 general plan second tier addition. The majority of the growth in both the base tier and the second tier addition is in office development. Office space increases 190% and 225% respectively in the two tiers while other types of commercial development increase by only 10 and 23 percent respectively. In both tiers the additional non-office commercial growth is assumed to occur in the retail and restaurant sectors and is split 88% and 12% respectively in both tiers. An 850 room, 640,000 square foot hotel would also be added with the second tier development.

B. ENERGY CONSUMPTION

1980 Baseline Energy Use. Table IV-2 lists actual delivered energy used in the commercial sector for the calendar year 1980. The base information was provided by PG&E's Economics and Statistics Department. The 1980 energy use statistics are considered representative of the existing rates and it is assumed that there has been a negligible increase in commercial development from 1980 to the present.

1990 Projected Energy Demand. In order to estimate 1990 operation energy consumption for both the general plan base tier commercial development and for the additional development in the second tier plan, several bits of information were necessary. First, the amount of growth expected for each tier was needed. This information is presented in Table IV-1. Next, it was necessary to establish the percentage of the existing building stock which was built prior to or after Title 24 standards came into effect. It was then necessary to estimate, for each of the commercial sectors, the replacement rate of the older building by 1990. Because building stock and replacement rate data for Cupertino were not available, data collected for the San Diego area by the California Energy Commission was used, under the assumption that the two areas are comparable. Table IV-3 lists the building stock make-up and the assumed replacement rates from 1975 through 1990 for the City of Cupertino.

Once the make-up of the building stock was established, average per square foot energy consumption figures for the new 1990 development were applied to the growth projections and total commercial sector 1990 direct delivered energy consumption was calculated. Tables IV-4 and IV-5 list the average per square foot energy consumption for pre and post Title 24 construction for each sector of the commercial development. Table IV-6 lists the average per square foot energy consumption rates for actual building stock during the 1979-1980 year. Table IV-7 summarizes the total 1990 estimated energy consumption for the 1980 base building stock combined with both 1990 growth tiers. The data is presented by each commercial sector and summed as a running total for each additional growth level.

The 1990 base tier and second tier commercial growth would create 36% and 87% delivered energy demand increases over 1980 base energy use in the commercial sector. These increases in energy demand will be even larger if the replacement rate of the older, less energy efficient buildings is less than assumed in this analysis. Using the replacement rates listed in Table IV-3, the 1980 commercial building stock would increase energy efficiency through the replacement of older buildings with more energy efficient ones, thus reducing energy demand for the 1980 base building stock an estimated 4.4% by 1990.

The estimated primary energy demand by 1990 increases 37% and 80% respectively for the base tier and second tier growth plans over 1980 levels compared to 50% and 90% respective increases in building stock square footage. Estimated primary demand would be $1{,}690 \times 10^9$ Btus under the base tier and $2{,}220 \times 10^9$ Btus under the second tier plan.

Annualized embodied energy for the commercial building sectors is assumed to be 20% of annual primary demand[1] or 338×10^9 Btus under the base tier plan and 444×10^9 under the second tier plan.

C. POTENTIAL ENERGY CONSERVATION

There are potentially two ways to mitigate the impacts of increased energy demand in the commercial sector created by the growth schedule under the base tier and second tier plans. The first method would be to incorporate more energy efficient design (beyond Title 24 standards) into all new construction and retrofit existing structures with cost effective energy conservation systems. The second method would be to simply reduce the amount of new development planned for under both tiers which would of course reduce the energy demand created by the new development.

Table IV-8 lists potential energy savings from applying a package of energy conservation techniques to all new commercial buildings built under the base and second tier plans and retrofitting 50% of the existing building by 1990. The conservation package would reduce energy consumption patterns below Title 24 standards. This package would include insulation, ventilation, and day lighting to reduce heating and cooling loads, solar hot water heating for low temperature industrial and normal commercial uses, and solar space heating for industrial process heat. All these conservation techniques have estimated payback periods of less than 10 years. As Table IV-8 shows, it is estimated that if this conservation pack-

[1] Source: Sedway/Cooke

age is applied, 1990 projected direct energy consumption could be reduced by as much as 58% under the second tier growth plan. With the conservation package the 1990 second tier growth plan would raise delivered energy demand only 8% over 1980 levels. The majority of delivered energy saved by the conservation package is in the form of natural gas. Natural gas use would be reduced to a level approximately 45% of that shown in Table IV-7 and electrical energy to approximately 75%.

TABLE IV-1

CITY OF CUPERTINO
COMMERCIAL BUILDING STOCK [1]
(x 1000 square feet)

Existing Stock[2] (1/1/83)	1990 General Plan Base Tier	1990 General Plan Second Tier
3,919	5,865	6,807*

[1] Includes office development.
[2] Source: Planning Department, City of Cupertino
* In addition, an 850 room, 640,000 square foot hotel will be developed.

TABLE IV-2

CITY OF CUPERTINO
PG&E GAS AND ELECTRIC SALES FOR THE COMMERCIAL
AND PUBLIC SERVICE SECTOR IN 1980

LAND USE	SIC CODES	DTH	KWH	TOTAL BTUs X 10^9
Office	60-67, 81, 83-96 (including state office and public safety)	32,061.1	14,798,129	82.5
Retail	52, 53, 55-57, 59, 72, 76	23,281.1	33,463,879	137.0
Restaurants	58	81,898.6	12,734,947	125.0
Food Stores	54	9,184.5	12,969,127	53.2
Warehouse	50, 51	926.9	318,664	2.0
Schools	82	114,135.0	14,039,320	162.0
Hospital	80	16,042.0	1,767,717	22.0
Hotel/Motel	70	2,641.8	163,080	3.2
Misc.	75, 78, 79 + uncoded	12,653.2	7,351,878	37.7
TOTAL				624.6

TABLE IV-3

CITY OF CUPERTINO
BUILDING STOCK REPLACEMENT RATE

	% Stock 1975 or Earlier		% Stock Post 1975		% of 1975 Based Stock Replaced		% of 1980 Based Stock Replaced
	1979	1990	1979	1990	1979	1990	1990
Office	80.4	46.3	19.6	53.7	4.1	27.3	18
Retail	75.7	38.4	24.3	61.6	4.3	26.3	15
Restaurants	86.7	57.4	13.3	42.6	2.2	18.3	13
Food Stores	75.7	38.4	24.3	61.6	4.3	26.2	15
Warehouse	71.4	41.0	28.6	59.5	4.3	25.9	15
Schools	92.8	76.8	7.2	23.2	2.2	18.5	15
Medical Facilities	91.1	64.1	8.1	35.9	5.7	29.1	21
Hotel/Motel	90.1	61.0	9.9	39.0	2.5	21.8	12
Misc.	88.0	50.6	12.0	49.4	5.2	31.1	22
Total	83.5	51.4	16.5	48.6	3.8	24.5	16

Source: San Diego Gas and Electric, assumes replacement rate for San Diego and Cupertino are equivalent.

TABLE IV-4

PG & E SERVICE AREA
AVERAGE ENERGY CONSUMPTION ON SITE
PRE-TITLE 24 STOCK
(BTUs X 10^3/SQ. FT.)

	SH	AC	VENT	WHSE	LIGHT	MISC.	TOTAL
Office							
Electric	10.32	28.89	5.79	2.41	28.14	.44	75.99
Natural Gas	23.79	109.40	0.00	4.04	0.00	7.51	144.74
Subtotal	34.11	138.29	5.79	6.45	28.14	7.95	220.73
Retail							
Electric	26.95	26.74	5.14	4.82	31.12	.36	95.13
Natural Gas	47.08	103.17	0.00	17.84	0.00	20.45	188.54
Subtotal	74.03	129.91	5.14	22.66	31.12	20.81	283.67
Restaurant							
Electric	280.43	27.74	12.17	57.97	33.53	.39	409.23
Natural Gas	452.44	94.42	0.00	99.72	0.00	11.62	658.20
Subtotal	732.87	119.16	12.17	157.69	33.53	12.01	1,067.43
Food Stores							
Electric	113.95	4.97	10.15	109.34	55.32	.27	294.00
Natural Gas	202.92	25.59	0.00	503.60	0.00	0.00	732.11
Subtotal	316.87	30.56	10.15	612.94	55.32	.27	1,026.11
Warehouse							
Electric	40.26	22.42	1.21	5.08	11.93	.59	81.49
Natural Gas	57.30	78.97	0.00	23.85	0.00	0.00	160.12
Subtotal	97.56	101.39	1.21	28.93	11.93	.59	241.61
Schools (University Data)							
Electric	20.87	6.33	1.56	5.12	21.63	.40	55.91
Natural Gas	35.79	22.11	0.00	8.60	0.00	35.28	101.78
Subtotal	56.66	28.44	1.56	13.72	21.63	35.68	157.69
Medical Facilities							
Electric	9.63	26.88	6.65	18.10	33.08	2.28	96.57
Natural Gas	24.27	91.56	0.00	29.22	0.00	4.18	149.23
Subtotal	33.90	118.39	6.65	47.32	33.08	6.46	245.80
Hotel/Motel							
Electric	20.88	33.64	8.80	10.50	16.05	.51	90.38
Natural Gas	32.17	122.19	0.00	17.49	0.00	42.40	214.25
Subtotal	53.05	155.83	8.80	27.99	16.05	42.91	304.63
Miscellaneous							
Electric	12.65	11.86	2.78	1.05	15.41	1.29	45.04
Natural Gas	18.92	41.95	0.00	.97	0.00	13.28	75.12
Subtotal	31.57	53.81	2.78	2.02	15.41	14.57	120.16

The formula used to calculate the information listed above is as follows:
$ax + b(cx)$ = average delivered energy consumption in 1979 building stock as recorded by PG&E; BTUs X 10^3/sq. ft. (Table IV-6)

where a = % 1979 stock which is pre Title 24 construction (Table IV-3)
b = % 1979 stock which is post Title 24 construction (Table IV-3)
c = 1-% reduction in energy use from pre Title 24 to Title 24 construction (Source: California Energy Commission)
x = pre Title 24 energy consumption (BTU's X 10^3/sq. ft.)

TABLE IV-5

PG & E SERVICE AREA
AVERAGE ENERGY CONSUMPTION ON SITE
POST-TITLE 24 STOCK
(BTUs X 10^3/SQ. FT.)

	SH	AC	VENT	WHSE	LIGHT	MISC.	TOTAL
Office							
Electric	3.33	11.50	4.16	1.46	22.09	.44	42.98
Natural Gas	8.11	47.15	0.00	2.30	0.00	7.09	64.65
Subtotal	11.44	58.65	4.16	3.76	22.09	7.53	107.63
Retail							
Electric	8.95	12.22	3.32	3.84	31.12	.36	59.81
Natural Gas	19.77	49.52	0.00	11.68	0.00	15.32	96.29
Subtotal	28.72	61.74	3.32	15.52	31.12	15.68	156.10
Restaurant							
Electric	241.17	9.79	10.09	57.97	22.90	.39	342.31
Natural Gas	401.31	41.17	0.00	93.04	0.00	8.72	544.24
Subtotal	642.48	50.96	10.09	151.01	22.90	9.11	886.55
Food Stores							
Electric	61.76	2.05	9.86	87.91	55.32	.27	217.17
Natural Gas	123.17	11.16	0.00	377.70	0.00	0.00	512.03
Subtotal	184.93	13.21	9.86	465.61	55.32	.27	779.20
Warehouse							
Electric	22.99	14.26	1.03	5.08	11.93	.59	55.88
Natural Gas	32.78	58.44	0.00	22.20	0.00	0.00	113.42
Subtotal	55.77	72.70	1.03	27.78	11.93	.59	169.30
Schools (University Data)							
Electric	11.73	2.76	.37	3.12	21.63	.40	40.01
Natural Gas	24.80	10.61	0.00	5.04	0.00	33.34	73.79
Subtotal	36.53	13.37	.37	8.16	21.63	33.74	113.80
Medical Facilities							
Electric	4.32	18.54	6.21	16.87	33.08	2.28	81.30
Natural Gas	20.29	68.58	0.00	27.14	0.00	3.14	119.15
Subtotal	24.61	87.12	6.21	44.01	33.08	5.42	200.45
Hotel/Motel							
Electric	16.89	23.75	8.22	9.76	16.05	.51	75.18
Natural Gas	26.89	92.62	0.00	16.32	0.00	42.40	178.23
Subtotal	43.78	116.37	8.22	26.08	16.05	42.91	253.41
Miscellaneous							
Electric	5.75	5.98	2.61	.66	8.10	1.29	24.39
Natural Gas	10.54	22.73	0.00	.57	0.00	12.46	46.30
Subtotal	16.29	28.71	2.61	1.23	8.10	13.75	70.69

Calculated using percent reduction in energy use from pre Title 24 construction to post Title 24 construction. (Source: California Energy Commission)

TABLE IV-6

PG & E SERVICE AREA
AVERAGE ENERGY CONSUMPTION ON SITE
1979 STOCK
(BTUs X 10^3/SQ. FT.)

	SH	AC	VENT	WHSE	LIGHT	MISC.	TOTAL
Office							
Electric	8.95	25.48	5.47	2.22	26.96	.44	69.52
Natural Gas	20.72	97.15	0.00	3.70	0.00	7.43	129.00
Subtotal	29.67	122.63	5.47	5.92	26.96	7.87	198.52
Retail							
Electric	22.58	23.21	4.70	4.58	31.12	.36	86.55
Natural Gas	40.44	90.17	0.00	16.34	0.00	19.20	166.15
Subtotal	63.02	113.38	4.70	20.92	31.12	19.50	252.70
Restaurant							
Electric	275.10	22.76	11.89	57.97	32.12	.39	400.23
Natural Gas	445.65	87.34	0.00	98.82	0.00	11.24	643.05
Subtotal	720.75	110.10	11.89	156.79	32.12	11.63	1,043.38
Food Stores							
Electric	101.30	5.80	10.08	104.13	55.32	.27	276.90
Natural Gas	183.54	22.08	0.00	473.01	0.00	0.00	678.63
Subtotal	284.84	27.88	10.08	577.14	55.32	.27	955.53
Warehouse							
Electric	35.32	20.09	1.16	5.08	11.93	.59	74.17
Natural Gas	50.29	73.10	0.00	23.38	0.00	0.00	146.77
Subtotal	85.61	93.19	1.16	28.46	11.93	.59	220.94
Schools (University Data)							
Electric	20.20	6.07	1.48	4.98	20.08	.37	53.18
Natural Gas	35.00	21.28	0.00	8.36	0.00	35.14	99.78
Subtotal	55.20	27.35	1.48	13.34	20.08	35.51	152.96
Medical Facilities							
Electric	9.12	25.95	6.57	17.85	30.14	2.08	91.71
Natural Gas	23.76	88.91	0.00	28.81	0.00	4.06	145.54
Subtotal	32.88	114.86	6.57	46.66	30.14	6.14	237.25
Hotel/Motel							
Electric	20.48	32.97	8.74	10.43	14.46	.46	87.54
Natural Gas	31.66	119.26	0.00	17.37	0.00	38.20	206.49
Subtotal	52.14	152.23	8.74	27.80	14.46	38.66	294.03
Miscellaneous							
Electric	11.82	11.16	2.76	1.0	14.53	1.14	42.41
Natural Gas	17.92	39.64	0.00	.92	0.00	13.17	71.65
Subtotal	29.74	50.80	2.76	1.92	14.53	1.14	114.06

Source: P.G. & E.

TABLE IV-7

CITY OF CUPERTINO
1990 DELIVERED ENERGY CONSUMPTION BY
COMMERCIAL AND SERVICE LAND USES
(BTUs X 10^9)

LAND USE	1980 Stock Non Redeveloped		1980 Stock Redeveloped[1]			BASE TIER STOCK ADDITION (Post T-24)			2ND TIER STOCK ADDITION (Post T-24)		
	Electric	N. Gas	Electric	N. Gas	Total	Electric	N. Gas	Total	Electric	N. Gas	Total
Office	41.41	26.32	5.64	2.89	76.26	69.41	104.41	250.08	23.72	35.69	309.49
Retail	97.19	19.79	11.85	2.02	130.85	17.40	28.02	176.27	20.53	33.05	229.85
Restaurants	37.67	71.25	4.84	9.05	122.81	13.69	21.77	158.27	16.02	25.47	199.76
Food Stores	37.71	7.80	5.19	.11	50.81	0	0	50.81	0	0	50.81
Warehouse	.93	.79	.12	.11	1.95	0	0	1.95	0	0	1.95
Schools (College)	40.61	97.02	5.39	12.66	155.68	0	0	155.68	0	0	155.68
Medical Facilities	4.77	12.67	1.12	2.76	21.32	0	0	21.32	0	0	21.32
Motel/Hotel	.49	2.32	.06	.27	3.14	0	0	3.14	48.12	114.07	165.33
Miscellaneous	19.57	9.87	3.17	1.80	34.41	0	0	34.41	0	0	34.41
TOTAL	280.35	247.83	37.38	31.67	597.23	100.50	154.20	851.93	108.39	208.28	1,168.60

[1] It is assumed that the stock replaced is not uniformly pre Title 24 construction but has the same ratio of pre Title 24 buildings and Title 24 buildings as the overall stock in 1980. All new stock is assumed to meet Title 24 standards.

TABLE IV-8

CITY OF CUPERTINO
1990 POTENTIAL DELIVERED ENERGY SAVINGS IN COMMERCIAL AND SERVICE LAND USES THROUGH PASSIVE/ACTIVE CONSERVATION TECHNIQUES[1]
(BTUs X 10^9)

Land Use	1980 STOCK Non Redeveloped		Redeveloped	Base Tier Stock	2nd Tier Stock	Total
Office						
Typical 1990 Construction	67.73		8.53	173.82	59.41	309.49
With Passive	49.92	*	4.26	86.91	29.70	167.59
% Savings	31%		50%	50%	50%	46%
Retail						
Typical 1990 Construction	116.98		13.87	45.42	53.58	229.85
With Passive/Active	80.72	*	8.37	27.40	32.32	148.81
% Saving	31%		40%	40%	40%	33%
Restaurant						
Typical 1990 Construction	108.92		13.89	35.46	41.49	199.76
With Passive/Active	80.06	*	7.36	18.79	21.99	128.20
% Savings	26%		47%	47%	47%	36%
Foodstores						
Typical 1990 Construction	45.51		5.30	0	0	50.81
With Passive/Active	34.59	*	3.53	0	0	38.12
% Savings	24%		34%	-	-	25%
Warehouse						
Typical 1990 Construction	1.72	*	.23	0	0	1.95
With Passive/Active	1.12		.10	0	0	1.22
% Savings	35%		57%	-	-	37%
Schools						
Typical 1990 Construction	137.63		18.05	0	0	155.68
With Passive/Active	96.34		9.21	0	0	105.55
% Savings	30%		49%	-	-	32%
Medical Facilities						
Typical 1990 Construction	17.44		3.88	0	0	21.32
With Passive/Active[2]	-		-	-	-	-
—	-		-	-	-	-
Motel/Hotel						
Typical 1990 Construction	2.81		.33	0	162.19	165.33
With Passive/Active	2.04		.17	0	85.96	88.17
% Savings	27%		47%	-	47%	47%
Miscellaneous						
Typical 1990 Construction	29.44		4.97	0	0	34.41
—	-		-	-	-	-
—	-		-	-	-	-
TOTAL						
Typical 1990 Construction	528.18		69.50	254.70	316.67	1,168.60
With Passive/Active	341.59		33.00	133.10	169.97	677.66
% Savings	35%		52%	48%	46%	42%

[1] Source: Sedway/Cooke Marin Countywide Plan Update, Appendix B Technical Report #10, August 1980.

[2] Data not available.

* Assume 50% of non-redeveloped 1980 building stock is retrofitted.

V. INDUSTRIAL ENERGY USE

A. INDUSTRIAL STOCK

The City of Cupertino has an existing industrial stock of approximately 4,370,000 square feet. This industrial stock is made up of industrial development in the following areas:

- Agriculture
- Agricultural services
- Building construction
- General construction
- Special trade construction
- Food processing
- Apparel manufacturing
- Printing
- Chemical manufacturing
- Petroleum refining
- Plastics production
- Fabricated metal production
- Mechanical machinery production
- Electrical machinery production
- Fine instrument production
- Railroad transportation systems
- Motor freight transportation systems
- Water transportation systems
- Air transportation systems
- Communications systems
- Utilities

The General Plan Base Tier growth will increase the City's industiral stock by 34% for 1990, up to 5,846,000 square feet. The Second Tier growth would increase industrial development in the City by 38% over existing levels, increasing the total industrial development in the City up to 6,028,000 square feet by 1990. This analysis assumes the agricultural uses which occur today will be replaced by other types of industrial development by 1990.[1] The electronics industries are expected to continue to expand, creating the growth projected in the First and Second Tier development plans.

B. ENERGY CONSUMPTION

Existing delivered energy consumption in the industrial sector was obtained using Pacific Gas and Electric (PG&E) statistics. 1980 energy consumption statistics were used to represent existing conditions. It is assumed that there has been little change in the energy consumption pattern between 1980 and 1983 because there has been little change in the industrial base.[2] Electrical machinery production is the major energy consuming use today.

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1 Source: City of Cupertino, Department of Planning.

2 Et al

Table V-1 lists the delivered energy consumption for the existing stock and for both the Base Tier and Second Tier 1990 growth alternatives. It is assumed that there will be no effective energy conservation in the industrial sector and thus the energy consumption per square foot remains the same between today and 1990. As stated earlier most of the industrial growth expected in the City will probably be in the electronics and computer industries. Most of the energy consumed in this industry is used for the manufacturing of semi-conductors. Though the electricity intensity has declined through 1976, according to the Annual Survey of Manufactures, the Santa Clara Manufacturers have indicated that the technology of making semi-conductor chips has changed, necessitating greater clean room air processing (i.e., the parts per million contamination has required substantial reduction). This requires more electricity consumption for fans and filters. Thus, while natural gas consumption may continue to decline, it is presumed that additional conservation savings in electricity will be negated by industrial process changes.[1]

Industrial annualized embodied energy is assumed to be approximately 20% of annual primary delivered energy use.[2] The total annual industrial energy use under the 1990 Second Tier Plan would be approximately $3,250 \times 10^9$ Btus (primary energy use plus annualized, embodied energy).

C. POTENTIAL ENERGY CONSERVATION

The only potential mitigation measure considered feasible at this time for reducing energy consumption in the industrial sector is to reduce the level of industrial development. Any reduction in development potential will reduce energy demand.

Reduction in energy demand per square foot of industrial development is not considered feasible at this time due to processing requirements.

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[1] Source: California Energy Commission, California Energy Demand 1980 to 2000: Revised Forecast for Consideration in the Proceedings on the Third Biennial Report. Vol. I Technical Report. Revised November 1980. P101-80-008.

[2] Source: Sedway/Cooke

TABLE V-1

DELIVERED ENERGY CONSUMPTION IN THE INDUSTRIAL SECTOR
(SIC Codes 07, 15, 17, 20, 27, 29, 30, 34-36, 38, 42, 43, 47, 49)

DEVELOPED SPACE (sq. ft.)	AVERAGE DELIVERED ENERGY[1] (per sq. ft.)		TOTAL DELIVERED ENERGY[2]		TOTAL BTUS x 10^9
	Natural Gas (Dths)	Electric (KWH)	Natural Gas (Dths)	Electric (KWH)	
Existing Stock[3] (1/1/83) 4,370,000	.05	40.4	223,343.9	176,587,975	827.0
G.P. Base Tier[4] (1990) 5,846,000	.05	40.4	292,300.0	236,178,400	1,097.0
G.P. Second Tier[5] (1990) 6,028,000	.05	40.4	301,400.0	243,531,200	1,134.2

[1] Assumes the unit energy consumption remains the same from 1980 thru 1990.

[2] Source: PG&E for 1980.

[3] Source: City of Cupertino.

[4] Source: City of Cupertino.

[5] Source: City of Cupertino.

VI. TRANSPORTATION ENERGY USE

A. CURRENT CONDITIONS

The private automobile is by far the most dominant form of transportation in the City of Cupertino and the surrounding Santa Clara County. According to the 1980 U.S. Census, the vast majority (89%) of all working individuals over the age of 16 travel to work by car. Of the remainder of the working force 1% work at home, 2% walk to work, 3% used public transit and 5% used motorcycles, bicycles or other means of transport.

Because almost all work and non-work related trips in the Cupertino area take place in a private automobile almost all operational energy consumed for transportation is consumed by autos in the form of gasoline. This energy analysis focuses on increased auto and truck traffic as the transportation modes with the most potential to increase or decrease operational transportation energy demand.

The main concern of this analysis is the energy impacts of the City's General Plan base tier growth versus the impacts of the second tier growth. Energy consumption of through traffic has not been calculated because it does not vary with the growth alternatives. This analysis calculates energy consumption for each land use and compares changes in traffic and energy consumption for each alternative but ignores through traffic flow which is unchanged in each alternative.

B. ENERGY CONSUMPTION

In order to estimate operational energy consumption in the transportation sector three major pieces of information must be known. These factors are:

1) The number of vehicle trips
2) The length of the trips
3) The fuel consumption rate of the average vehicle on each trip.

Once these factors are known they can be multiplied to arrive at the overall operational energy consumption. Tables VI-1 through VI-15 illustrate the methodology used to arrive at the annual operational transportation energy use total listed in Table VI-15.

Table VI-1 lists 1980 base year and projected 1990 a.m. peak hour traffic volumes as provided by the City's General Plan Amendment Traffic Technical Appendix, dated June 1982. The peak hour data in Table VI-1 was combined with average weekday daily vehicle trip rates per land use generation factors to arrive at the peak hour and non-peak hour total trip data listed in Tables VI-2 through VI-6. The volume of trips generated was calculated for each trip generation land use (jobs or housing) for the 1980, the 1990 base tier and 1990 second tier level development.

Table VI-7 summarizes the average weekday trip volume information and multiplies it by average trip length factors to arrive at total weekday mileage data for peak hour and non-peak hour periods. It is assumed that 3% of the peak hour mileage and 10% of the non-peak hour mileage is truck traffic. The remainder of the mileage is personal autos.

Tables VI-8 and VI-9 break the average weekday mileage data found in Table VI-7 into truck and auto average weekday data. Fuel consumption rate estimates are

then applied to the average weekday mileage data to arrive at fuel consumption estimates. Average age of all personal automobiles on the road, the frequency of stops per mile and the level of traffic congestion all were factors considered in developing the fuel consumption rates.[1]

Tables IV-10 and VI-11 present auto and truck fuel consumption figures for average weekend days. Auto traffic on weekends is assumed to be 90% of weekday levels and congestion is assumed to be at the same level as weekday non-peak hour periods. Weekend truck traffic congestion is assumed to be at the same level as weekday non-peak hour periods and is assumed to be 10% of average weekday volume levels.

Tables VI-12 through VI-14 combine the fuel consumption figures for average weekends and weekdays to get annual fuel consumption figures. Table VI-15 compares annual transportation direct energy consumption for 1980, base tier 1990 and second tier 1990.

1980 Baseline Energy Use 1980. Direct transportation energy consumption in the City of Cupertino was approximately 56 million gallons of gasoline or an equivalent of $7{,}000 \times 10^9$ BTUs per year. Not only does transportation consume the most rapidly depleting form of energy but direct transportation energy consumption or the amount of gasoline burned up in cars each year, amounted to 72% of the total delivered energy consumed in the City of Cupertino. This is far above the national average of around 25%.

1990 Projected Energy Demand. Under both the base tier and second tier growth projections the operational transportation energy demand is estimated to decline. Although total mileage traveled increases due to the additional development it is more than offset by the expected increase in fuel efficiency of the average personal auto by 1990. The decrease in demand assumes that congestion levels will remain the same and the number and length of trips remains the same. If, however, any of these factors increases or the fuel efficiency of the average vehicle does not improve as much as extected, then transportation energy demand could rise with the increased vehicle mileage generated by the additional development.

1980 embodied energy calculations for the transportation sector range from 20% to 30% of operational energy on an annualized basis. However, this percentage is expected to rise for 1990 as the fuel efficiency of the average vehicle goes up and operational energy consumption comes down.[2]

C. POTENTIAL ENERGY CONSERVATION

Although both the base tier and second tier estimated operational transportation energy demand figures are below current (1980) levels they still represent enormous amounts of energy consumption with great potential for reduction through simple conservation techniques.

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[1] Source of fuel consumption rates; Caltrans, Office of Transportation Laboratory, Department of Construction, "Energy and Transportation Systems Final Report," December 1978, pp. A-29 through A-46.

[2] Source: Sedway/Cooke

Currently, approximately 20% of the working individuals in Santa Clara County and the City of Cupertino car pool to work.[1] The majority of them commute in 2 person carpools. Table VI-16 illustrates the energy savings which could be achieved under the 1990 second tier scenario if the carpool rate was raised to 50% of peak hour commuters carpooling in 3 person carpools. This conservation technique could save over 2 million gallons of gasoline, reducing estimated operational transportation energy demand to 64% of total delivered energy demand in the transportation sector. Additional potential mitigation measures which could greatly reduce transportation energy demand include:

- o Further increases in the average occupant per car
- o Reduction of the number of trips necessary by combining shopping, recreational and work trips
- o Reduction of the length of trips by locating housing near jobs
- o Using alternatives to the automobile such as mass transit, bicycles, walking, etc.,
- o Reduction of congestion through synchronization of traffic signals, etc.

Some of these mitigation measures are purely physical changes which require only technical fixes before energy can be saved, others are more psychological in nature and will require behavioral changes from individuals before energy saving can be achieved. In order to produce a significant reduction in energy demand all of the mitigation measures mentioned here would have to be implemented.

[1] 1980 U.S. Census

TABLE VI-1

CITY OF CUPERTINO
PEAK HOUR TRAFFIC[1]

	1980	1990 Base Tier	1990 Second Tier
Housing	14,380	17,423	17,423
Jobs	8,036	12,701	14,233 [2]
Thru	12,209	15,139	15,139
TOTAL	34,625	45,263	46,795

[1] City of Cupertino, "General Plan Amendment, Technical Appendix - Traffic," June 1982

[2] Increased at the same proportion per sq. ft. as the base tier.

TABLE VI-2

CITY OF CUPERTINO
1980 AVERAGE WEEKLY HOUSING GENERATED VEHICLE TRIPS

Density Range Units/Acre	Total # of Units	Average Daily Vehicle Trips Per Unit[1]	Peak Hour Trips Per Unit[2] A.M. & P.M.	Non-Peak Hour Trips Per Unit	Total Peak Hour Trips A.M. & P.M.	Total Non-Peak Hour Trips
Less than 1	680	12	2	10	1,360	6,800
1-5	9,750	10	1.8	8.2	17,550	79,950
5-10	2,450	9	1.8	7.2	4,410	17,640
10-20	3,210	8	1.8	6.2	5,780	19,900
Total					29,100	124,290

[1] Caltrans

[2] Sedway/Cooke

TABLE VI-3

CITY OF CUPERTINO
1990 BASE TIER AVERAGE WEEKDAY HOUSING GENERATED VEHICLE TRIPS

Density Range Units/Acre	Total # of Units	Average Daily Vehicle Trips Per Unit	Peak Hour Trips Per Unit A.M. & P.M.	Non-Peak Hour Trips Per Unit	Total Peak Hour Trips A.M. & P.M.	Total Non-Peak Hour Trips
Less than 1	1,680	12	2	10	3,360	16,800
1-5	10,350	10	1.8	8.2	18,630	84,870
5-10	2,700	9	1.8	7.2	4,860	19,440
10-20	3,770	8	1.8	6.2	6,790	23,370
20-35	1,110	6	1.8	5.2	2,000	5,770
Total					35,640	150,250

TABLE VI-4

CITY OF CUPERTINO
1980 WEEKDAY JOBS GENERATED VEHICLE TRIPS

Land Use	Square Feet X 1000	Average Daily Vehicle Trips Per 1000 Sq. Ft.[1]	Peak Hour Trips Per 1000 Sq. Ft. A.M. & P.M.[1]	Non-Peak Hour Trips Per 1000 Sq. Ft.	Total Peak Hour Trips A.M. & P.M.	Total Non-Peak Hour Trips
Commercial	3,069	35	1.28	33.72	3,930	103,490
Office	850	12.3	4.52	7.78	3,840	6,610
Industrial	4,370	5.4	1.90	3.5	8,300	15,300
Total					16,070	125,400

[1] Source: Institute of Transportation Engineers, "Trip Generation," 1979

TABLE VI-5

CITY OF CUPERTINO
1990 BASE TIER WEEKDAY JOBS GENERATED VEHICLE TRIPS

Land Use	Square Feet X 1000	Average Daily Vehicle Trips Per 1000 Sq. Ft.[1]	Peak Hour Trips Per 1000 Sq. Ft. A.M. & P.M.[1]	Non-Peak Hour Trips Per 1000 Sq. Ft.	Total Peak Hour Trips A.M. & P.M.	Total Non-Peak Hour Trips
Commercial	3,400	35	1.28	33.72	4,350	114,650
Office	2,465	12.3	4.52	7.78	11,140	19,180
Industrial	5,846	5.4	1.90	3.5	11,110	20,460
Total					26,600	154,290

[1] Source: Institute of Transportation Engineers, "Trip Generation," 1979

TABLE VI-6

CITY OF CUPERTINO
1990 BASE TIER PLUS SECOND TIER
AVERAGE WEEKDAY JOBS GENERATED VEHICLE TRIPS

Land Use	Square Feet X 1000	Average Daily Vehicle Trips Per 1000 Sq. Ft.	Peak Hour Trips Per 1000 Sq. Ft. A.M. & P.M.	Non-Peak Hour Trips Per 1000 Sq. Ft.	Total Peak Hour Trips A.M. & P.M.	Total Non-Peak Hour Trips
Commercial	3,790	35	1.28	33.72	4,850	127,800
Office	3,017	12.3	4.52	7.78	13,640	23,470
Industrial	6,028	5.4	1.90	3.5	11,450	21,100
Hotel	640	13.9	2.10	11.8	1,340	7,550
Total					31,280	179,920

TABLE VI-7

CITY OF CUPERTINO
TOTAL AVERAGE WEEKDAY TRIP MILEAGE GENERATION
(includes autos & trucks)

Land Use	Total Number of Trips: Peak Hour A.M. & P.M.	Total Number of Trips: Non Peak Hours	Average Trip Length (miles): Peak Hour A.M. & P.M.[1]	Average Trip Length (miles): Non Peak Hour[2]	Total Mileage: Peak Hour A.M. & P.M.	Total Mileage: Non Peak Hours
1980						
Housing	29,100	124,290	9.38	5	272,958	621,450
Jobs	16,070	125,400	7.29	5	117,150	627,000
Total	45,170	149,690	-	-	390,100 *	1,248,450 *
1990 Base Tier						
Housing	35,640	150,250	9.38	5	334,303	751,250
Jobs	26,600	154,290	7.29	5	193,914	771,450
Total	62,240	304,540	-	-	528,220 *	1,522,700 *
1990 Second Tier						
Housing	35,640	150,250	9.38	5	334,303	751,250
Jobs	31,280	179,920	7.29	5	228,031	899,600
Total	66,920	330,170	-	-	562,330 *	1,650,850 *

[1] Source: Metropolitan Transportation Commission, Guadalupe Corridor Phase II Alternatives Analysis D.E.I.S., Volume I, "Travel Mode Assumptions," page 181, September 1980

[2] Source: Sedway/Cooke

* Assume 3% of peak hour and 10% of non peak hour trips are truck traffic.

TABLE VI-8

CITY OF CUPERTINO
AVERAGE WEEKDAY PRIVATE AUTO FUEL CONSUMPTION*
(through traffic excluded)

Year	Total Mileage		Fuel Consumption Rate[1] (gallons per mile)		Fuel Consumption (gallons of gasoline)		
	Peak Hour A.M. & P.M.	Non Peak Hours	Peak Hour A.M. & P.M.	Non Peak Hour	Peak Hour A.M. & P.M.	Non Peak Hours	Total
1980	378,400	1,123,600	.102	.092	38,600	103,400	142,000
1990 Base Tier	512,400	1,370,400	.066	.060	33,800	82,200	116,000
1990 Second Tier	545,500	1,485,800	.066	.060	36,000	89,100	125,100

[1] Source: Caltrans, "Energy and Transportation Systems, Final Report," December 1978, pp. A-29 through A-40.
Assumes: Heavy traffic density for peak hour, light traffic density for non peak hour.
Frequency of stops, (7) per mile.

* Assumes 3% of peak hour, 10% of non peak hour weekday mileage (Table VI-7) is truck traffic.

TABLE VI-9

CITY OF CUPERTINO
AVERAGE WEEKDAY TRUCK TRAFFIC FUEL CONSUMPTION[1]
(through traffic excluded)

Year	Total Mileage		Fuel Consumption Rate[2] (gallons per mile)		Fuel Consumption (gallons of gasoline)		
	Peak Hour A.M. & P.M.	Non Peak Hours	Peak Hour A.M. & P.M.	Non Peak Hour	Peak Hour A.M. & P.M.	Non Peak Hours	Total
1980	11,700	124,800	.188	.186	2,200	23,200	25,400
1990 Base Tier	15,800	152,300	.188	.186	3,000	28,300	31,300
1990 Second Tier	16,800	165,100	.188	.186	3,200	30,700	33,900

[1] Assumes 3% of peak hour, 10% of non peak hour weekday mileage (Table VI-7) is truck traffic.

[2] Caltrans, "Energy and Transportation Systems, Final Report," December 1978, pp. A-41 through A-46.
Assumes: Average truck; 2 axle, 6 tire, gasoline engine
Heavy traffic density for peak hour, light traffic density for non peak hour.
Frequency of stops, (7) per mile.

TABLE VI-10

CITY OF CUPERTINO
AVERAGE WEEKEND OR HOLIDAY PRIVATE AUTO FUEL CONSUMPTION
(through traffic excluded)

Year	Mileage[1]	Fuel Consumption Rate[2] (gallons per mile)	Total Fuel Consumption (gallons of gasoline)
1980	1,351,800	.092	124,400
1990 Base Tier	1,694,500	.060	101,700
1990 Second Tier	1,828,200	.060	109,700

[1] Weekend daily private auto mileage assumed to be 90% of weekday total.

[2] Caltrans, "Energy and Transportation Systems Final Report," December 1978 (assumed to be equal to weekway non peak hour rate).

TABLE VI-11

CITY OF CUPERTINO
AVERAGE WEEKEND OR HOLIDAY TRUCK FUEL CONSUMPTION
(through traffic excluded)

Year	Mileage[1]	Fuel Consumption Rate[2] (gallons per mile)	Total Fuel Consumption (gallons of gasoline)
1980	13,700	.186	2,500
1990 Base Tier	16,800	.186	3,100
1990 Second Tier	18,200	.186	3,400

[1] Weekend daily truck mileage assumed to be 10% of weekday total.

[2] Caltrans, "Energy and Transportation Systems Final Report," December 1978 (assumed to be equal to weekday non peak hour rate, average truck, 2 axle, 6 tire, gasoline engine)

TABLE VI-12

CITY OF CUPERTINO
1980 OPERATIONAL TRANSPORTATION ENERGY CONSUMPTION
(gallons of gasoline X 1000)

Days per Year	Weekday Private Auto	Weekend Private Auto	Weekday Truck	Weekend Truck	Total
240	142.0	-	25.4	-	40,176.0
125	-	124.4	-	2.5	15,862.5
Total					56,038.5

TABLE VI-13

CITY OF CUPERTINO
1990 BASE TIER OPERATIONAL TRANSPORTATION ENERGY CONSUMPTION
(gallons of gasoline X 1000)

Days per Year	Weekday Private Auto	Weekend Private Auto	Weekday Truck	Weekend Truck	Total
240	116.0	-	31.3	-	35,352.0
125	-	101.7	-	3.1	13,100.0
Total					48,452.0

TABLE VI-14

CITY OF CUPERTINO
1990 SECOND TIER OPERATIONAL
TRANSPORTATION ENERGY CONSUMPTION
(gallons of gasoline X 1000)

Days per Year	kday ıvate ıto	Weekend Private Auto	Weekday Truck	Weekend Truck	Total
240	5.1	-	33.9	-	38,160.0
125	.	109.7	-	3.4	14,137.5
Total					52,297.5

TABLE VI-15

CITY OF CUPERTINO
ANNUAL OPERATIONAL TRANSPORTATION ENERGY CONSUMPTION

Year	Gallons of Gasoline X 1000	BTUs X 10^9
1980	56,050	7,006
1990 Base Tier	48,450	6,056
1990 Second Tier	52,300	6,538

1 gallon of gasoline - 125,000 BTUs

TABLE VI-16

CITY OF CUPERTINO
POTENTIAL OPERATIONAL ENERGY SAVINGS
FROM INCREASED CARPOOLING
(Peak traffic period under 1990 Second Tier Plan)

	Under Current Carpool Trends[1]	Assumed Carpool Increase[2]	Savings
Total peak hour (a.m. & p.m) person trips	75,132	75,132	
Total peak hour Vehicle Trips			
Housing Generated	35,640	26,676	
Jobs Generated	31,280	23,412	
Average trip length (miles)			
Housing Generated	9.38	9.38	
Jobs Generated	7.29	7.29	
Total peak hour mileage[3]			
Housing Generated	334,303	250,022	
Jobs Generated	228,031	170,673	
Total	562,330	420,695	
Peak hour personal auto mileage	545,500	408,100	
Peak hour fuel consumption rate (gallons per mile)	.066	.066	
Fuel consumption per day (gallons of gasoline)	36,000	26,900	
Working days per year	240	240	
Fuel consumption per year (gallons of gasoline x 1000)	8,640	6,456	2,184

[1] 20% of working individuals carpool; 78% of those carpool in 2 person autos, 14% in 3 person autos, 5% in 4 person autos and 3% in 5 or more person carpools: Source: 1980 U.S. Census Data

[2] Assume 50% of peak hour person trips take place in 3 person carpool; the remainder of the person trips are in single occupancy vehicles.

[3] Includes service trucks, etc.

VII. GLOSSARY

Btu (British Thermal Unit)	The amount of heat required to raise one pound of water from 59°F to 60°F -- a unit used in the U.S. to measure thermal energy (heat).
Kwh (Kilowatt hour)	The standard measure of electrical energy consumption equal to 1000 watts consumed continously for one hour. Equal to 3,414 Btu/hr.
Delivered Energy	Energy received at the point of end use, e.g., the electricity or natural gas that enters the building envelope.
Primary Energy	The energy required to generate and transmit electrical energy; it takes approximately 3 units of primary energy, e.g., coal, to deliver 1 unit of electricity. This wasted energy is referred to as generation and transmission losses.
Embodied Energy	The energy bound into materials and goods during the manufacturing or construction processes, e.g., embodied energy in a house includes energy used to harvest, mill and transport lumber; to produce and transport masonry; etc. and energy consumed in the construction of the building.
Operational Energy	Is the opposite of embodied energy. It can be expressed in the form of delivered or primary energy and represents the energy consumed on a day to day basis to keep a building, auto, etc., functioning.
ENERGY CONVERSIONS	1 Kilowatt hour (kwh) - 3,413 Btu's 1 Therm of natural gas = 100,000 Btu's 1 Gallon automobile gasoline = 125,000 Btu's

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